Numerics of Dynamical Systems

Assignment 4

Conny Schweigert

Barcelona
24.03.2015

1

Listing 1: main_ls_flow.f

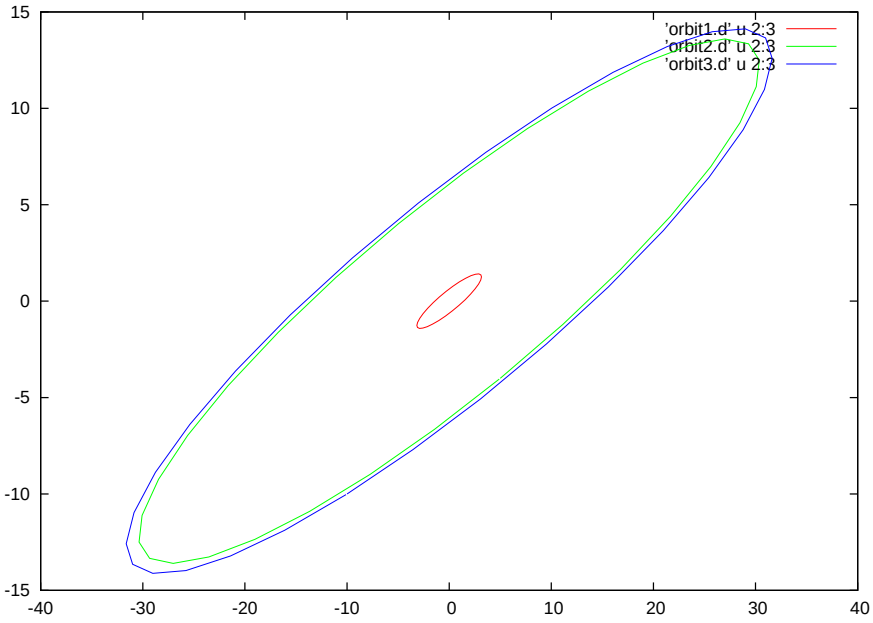
```
c*************************************************************
c
c  MAIN_OS_FLOW.f
c
c       We integrate the harmonic oscillator field with Taylor
c       from t=ti up to t=tmax
c       idir= +1 (integration forward in time); =-1 (backward)
c       np= number of intermediate points (apart from the initial one)
c           that we want to write on the file orbit.d. If np=1
c           only the initial and final points are written
c
c  input: xi,ti,tmax,idir,np
c*************************************************************
        implicit real*8 (a-h,o-z)
        parameter (n=2)
        dimension xi(n),x(n)
        common/param/aa,bb,cc,dd
        write(*,*)'a,b,c,d'
        read(*,*) aa,bb,cc,dd
        open(10,file='orbit.d',status='unknown')
        write(*,*) 'Initial condition x(1),x(2)'
        read(*,*) (xi(i),i=1,n)
        write(*,*) 'ti,tmax,np (number of points)'
        read(*,*)ti,tmax,np
c particular example integration up to t=pi
c         pi=4.d0*datan(1.d0)
c         tmax=pi/2.d0
        if (tmax.ge.ti)then
c         'idir (=1 forward in time, =-1 backward)'
            idir=1
        else
            idir=-1
        endif
        do i=1,n
         x(i)=xi(i)
        enddo
         write(*,*)ti,'   initial t, initial cond:'
```

```
          write(*,*)(x(i),i=1,n)
c REMARK: xinctime positive
        xinctime=dabs(tmax-ti)/np
          write (10,*)ti,(x(ii),ii=1,n)
        do 20 i=1,np
          call flow(ti,n,x,idir,xinctime)
          write (10,*)ti,(x(ii),ii=1,n)
 20     continue
        write(*,*)ti,'  final t,  final point:'
        write(*,*)(x(i),i=1,n)
         end


        subroutine flow(t,n,x,idir,xinctemps)
        IMPLICIT REAL*8 (A-H,O-Z)
        dimension x(n)
         common/param/aa,bb,cc,dd
c         write(*,*)'a,b,c,d'
c         read(*,*) aa,bb,cc,dd
        tmax=t+idir*xinctemps
c
c parameters for the integration
c
         hab=0.1e-16
         hre=0.1e-16
         pabs=dlog10(hab)
         prel=dlog10(hre)
c Option of control of step
         istep=1
         ht=0.d0
 1         CALL taylor_f77_eq_ls_(t,x,idir,istep,pabs,prel,
     &  tmax,ht,iordre,ifl)
c         write(10,100) t,(x(i),i=1,n)
         if (idir.eq.1.and.t.lt.tmax)go to 1
         if (idir.eq.-1.and.t.gt.tmax)go to 1
c check t=tmax
         if (dabs(t-tmax).le.1.d-13)return
         write(*,*)'problems in taylor'
         stop
c 100      format(f15.8,2f22.15)
         return
```

end

Abbildung 1: Center with initial conditions (1,1), (5,-4) and (-10,-10).



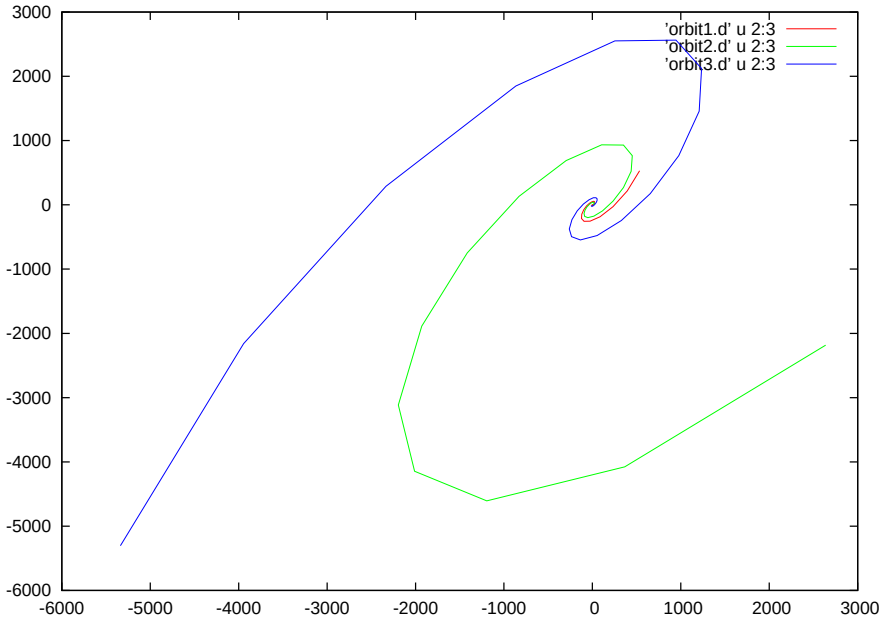
2 Saddle

The initial times for the 16 orbits are like this:

$s = 0.000001$, $v_1 = (0, 1)$, $v_2 = (0.7, -0.7)$, $t = 0.00000001$

- Orbit 1: $s \cdot v_1$, forward in time
- Orbit 2: $-s \cdot v_1$, forward in time
- Orbit 3: $s \cdot v_1$, backward in time
- Orbit 4: $-s \cdot v_1$, backward in time
- Orbit 5: $s \cdot v_2$, forward in time
- Orbit 6: $-s \cdot v_2$, forward in time
- Orbit 7: $s \cdot v_2$, backward in time

Abbildung 2: Focus with initial conditions (1,1), (5,-4) and (-10,-10).

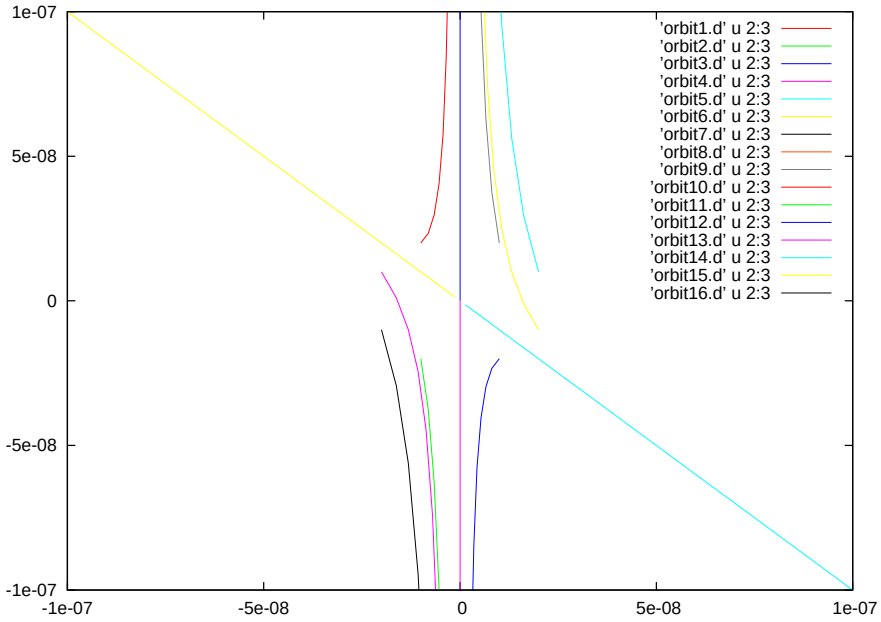


- Orbit 8: $-s \cdot v_2$, backward in time
- Orbit 9: $t \cdot (1, 2)$, forward in time
- Orbit 10: $t \cdot (-1, 2)$, forward in time
- Orbit 11: $t \cdot (-1, -2)$, forward in time
- Orbit 12: $t \cdot (1, -2)$, forward in time
- Orbit 13: $t \cdot (-2, 1)$, forward in time
- Orbit 14: $t \cdot (2, 1)$, forward in time
- Orbit 15: $t \cdot (2, -1)$, forward in time
- Orbit 16: $t \cdot (-2, -1)$, forward in time

For the bigger saddle I used these initial conditions:

- Orbit 1: $(0, 0.00002)$, forward in time
- Orbit 2: $(0, -0.00002$, forward in time

Abbildung 3: Saddle.



- Orbit 3: $(7, -7)$, forward in time
- Orbit 4: $(-7, 7)$, forward in time

Abbildung 4: Saddle in bigger coordinates.